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Canawa wheat shows the characteristic drooping spike. For comparison another pure-line selection of wheat with erect spikes is shown at the left

AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE, WEST VIRGINIA UNIVERSITY
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MORGANTOWN

Canawa---A New Variety of Soft Red Winter Wheat

by R. J. GARBER and L. S. BENNETT

THE ACTIVITIES carried on and designated by an agricultural experiment station as wheat breeding usually may be grouped under three headings, namely, (1) new introductions, (2) pure-line selections, and (3) hybridization. The first step in improving wheat by breeding is to grow and compare available strains that are adapted to the particular region. If the strains or varieties are not pure but consist of a mixture of types, head selections are made and true breeding strains established from them. In case it is desired to combine desirable characteristics found in different strains, the only known means of accomplishing this is by crossing or hybridization. The new variety of wheat described below was discovered by making head selections and then comparing their respective descendants over a period of years.

ORIGIN OF THE NEW WHEAT

In 1921 there were grown on the Agronomy Farm near Morgantown 19 varieties of soft winter wheat, each rather badly mixed. Something over 2100 head selections were made from these varieties and grown in individual plant rows in 1922. Among these were 125 head selections made from the variety grown under the name of Canada Hybrid. One of these head selections, namely, I-22-1125, is the parent of the new variety described below.

NAME AND BRIEF DESCRIPTION

The new variety has been named Canawa from the three words Canada and West Virginia. It has purplish stems, awnless *nodding* spikes, *white glabrous* glumes, and *semi-hard*, red, short seed. Accord-

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K. S. Quisenberry and M. M. Hoover, to whom the writers are indebted, had charge of the small grain nursery at successive periods during the progress of the investigation described in this bulletin. The writers are also indebted for the data collected at Lakin to T. C. McIlvaine, at Kearneysville to F. J. Schneiderhan, and at the cooperating farms to the several farmers whose kindly interest made the cooperative tests possible.

ing to Clark *et al.*[1],[2] Canadian Hybrid is grown under the synonyms Red May and Jones Fife. The former is described as stem purple, spike awnless, *erect to inclined*, glumes *brown* glabrous, and kernels *soft*, red, and usually short. Jones Fife is described as stem *white*, spike awnless nodding, glumes white *pubescent*, and kernels red, soft to semi-hard, and short to mid-long. In the above descriptions the underlined words indicate some of the contrasting characteristics between what may have been the parent variety and the selection.

During the twelve-year period 1923 to 1934 inclusive, Canawa has been grown in comparable rod-row tests at Morgantown with Trumbull and Fulhio, two pure-line selections made at the Ohio Agricultural Experiment Station, and well adapted, particularly Fulhio, to West Virginia.

TABLE 1—*Height, date ripe, and spring survival of certain varieties of wheat grown on the Agronomy Farm near Morgantown from 1923-1934, inclusive*

Variety	Average date ripe	Average spring survival (Estimated %)	Average height (inches)
(1)	(2)	(3)	(4)
Canawa	July 7.3	73.6	37.6
Fulhio	July 7.9	79.5	39.3
Trumbull	July 7.9	76.3	39.8

From Table 1, column 2, it is apparent that the average date ripe is approximately the same for the three wheats Canawa, Fulhio, and Trumbull. On the Agronomy Farm winter wheat usually is seeded about September 20. With respect to the estimated percentage of spring survival (column 3) there likewise is little difference among the three varieties, although Fulhio has slightly the highest and Canawa slightly the lowest average. In taking this note, an estimate of percent stand on each plat is made late in the fall and again in the spring when active growth begins. From these data the average percentages of spring survival are calculated. Relative heights of plants for the 12-year period are shown in column 4, Table 1. The average height in inches of Trumbull is 39.8, Fulhio 39.3, and Canawa 37.6. During the time these wheats have been under observation at Morgantown very little lodging has occurred among any of them. A small amount of lodging occurred in two replications of Canawa

[1]Clark, J. A., Martin, J. H., and Ball, C. R. Classification of American Wheat Varieties. U. S. D. A. Bul. 1074, 238 pp. 1922.

[2]Clark, J. A., and Bayles, B. B. Classification of Wheats Grown in the United States. U. S. D. A. Tech. Bul. 459, 164 pp. 1935.

during 1924 and in one replication of Fulhio and in 4 of the 49 plats of Trumbull in 1930. In fact, lodging of winter wheat is seldom a serious problem on the Agronomy Farm, attributable in part at least to the fact that the soil is low to medium in productivity.

RELATIVE YIELDS AT MORGANTOWN

In the varietal trials conducted at Morgantown and at Lakin each sort is grown in rod-row plats replicated four or five times. Each plat consists of 3 rows 18 feet long and one foot apart. The seed is sown by hand, 16.8 grams being used per row. At harvest 16 feet only of the central row is harvested for the yield determination.

Perhaps the most important characteristic for the West Virginia farmer to consider in choosing a variety of winter wheat is yielding ability. In Table 2 are shown the average annual yields as well as the average yields for the 12-year period of the three wheats grown at Morgantown. Column 14 shows there is little difference between Canawa and Fulhio but Trumbull is distinctly lower. The average yield in bushels per acre for the entire period of the test for Fulhio is 26.6, for Canawa 26.3, and for Trumbull 22.9. The average yield for the 12-year period of Canawa is significantly greater than that of Trumbull as determined statistically by the method of Student.[3, 4]

TABLE 2—*Wheat yields in bushels per acre obtained in the rod-row nursery from 1923 to 1934, inclusive, on the Agronomy Farm near Morgantown*

Variety	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	Ave.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Canawa (I-22-1125)	28.8	29.5	21.7	30.8	34.7	13.1	36.2	34.1	18.6	21.1	25.8	21.6	26.3*
Fulhio	19.6	34.5	23.5	30.9	28.5	27.1	34.9	32.9	25.1	17.1	22.4	22.7	26.6
Trumbull	21.1	24.4	14.8	29.1	26.9	19.1	30.1	26.4	22.1	16.7	21.7	22.9	22.9

*Significantly greater than the average of Trumbull.

In Table 3 the average yields obtained in the rod-row trials at Lakin are shown. Here the three wheats have been grown only during the period from 1931 to 1934, inclusive, which is hardly long enough to establish their relative merit for that locality. In average yields (column 6) for the four years the greatest difference between any two varieties is only 1.7 bushels with Trumbull again at the bottom and Canawa at the top of the list. The average yields in

[3] "Student." The Probable error of a mean Biometrika *6*: 1-26. 1908.

[4] ———— New tables for testing the significance of observations. Metron. *5*(3): 18-21. 1925.

bushels per acre are as follows: Canawa 29.9, Fulhio 28.9, and Trumbull 28.2.

At University Farm near Kearneysville, a varietal experiment similar to the one at Lakin has been carried on beginning with 1931. In 1933 no yield records were obtained and in 1932 and in 1934 all yields were very low. In 1931 and 1935, when satisfactory yields were obtained, Canawa produced an average of 27.6 bushels per acre and Fulhio and Trumbull each produced an average of 23.8 bushels per acre.

TABLE 3—*Wheat yields in bushels per acre obtained in the rod-row nursery from 1931 to 1934 inclusive at the Lakin Experiment Farm near Point Pleasant, W. Va.*

Variety	1931	1932	1933	1934	Average
(1)	(2)	(3)	(4)	(5)	(6)
Canawa (I-22-1125)	37.9	17.5	24.7	39.3	29.9
Fulhio	37.7	16.2	21.9	39.9	28.9
Trumbull	34.0	14.8	23.7	40.3	28.2

RELATIVE YIELDS ON WEST VIRGINIA FARMS

In addition to the yield tests carried out at Morgantown and Lakin a number of cooperative tests with Canawa in comparison with the owner's variety were made on certain West Virginia farms. Each cooperator was furnished with enough seed to enable him to drill in alternate adjoining strips the new variety for comparison with his own variety. There were three such strips of each variety, each strip at least two drill widths wide. At harvest single drill rows 16 feet long were removed from at least 5, and in a few cases 9, different places in each strip for the yield determinations. The rod-row samples were threshed and the weight of the grain determined at Morgantown.

In Table 4 are shown the average yields on those farms where it was reasonably certain that accurate records were obtained. In column 6 the average yields are given from four farms in 1931. The yields are: Canawa 22.0, and owner's variety 18.0 bushels per acre. On three of the farms Fulhio was included in the test and, as may be seen from the table, yielded only slightly less than Canawa. In 1932 yield data were obtained from three farms, the averages (column 10) of which are Canawa 31.8, and owner's variety 29.2 bushels per acre. In 1933 the corresponding averages (column 13) based on only two farms are 37.2 and 27.4 bushels per acre, respectively. The average

yield per acre obtained during the three years on the nine farms is significantly greater for Canawa (28.7 bu.) than that for the owner's variety (23.9 bu.).

In 1934 a more extensive test was conducted and as a result yield records are available from 11 farms. The average yields in bushels per acre as shown in column 25 are Canawa 37.2, and owner's variety 30.5. These averages also differ significantly according to the method of Student.

TABLE 4—*Wheat yields in bushels per acre obtained on certain farms in West Virginia in 1931 to 1934 inclusive*

Variety	Cooperators in 1931					Cooperators in 1932				Cooperators in 1933		
	A	B	C	D	Ave.	E	F	G	Ave.	H	I	Ave.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Canawa (I-22-1125)	28.3	17.6	11.9	30.3	22.0	21.7	24.4	49.3	31.8	29.4	45.1	37.2
Owner's variety	22.1	12.3	9.7	28.1	18.0	21.3	26.4	40.0	29.2	26.6	28.2	27.4
Fulhio	...	14.6	10.8	29.5	...	...	...	...	...	...	...	...

	Cooperators in 1934											
	J	K	L	M	N	O	P	Q	R	S	T	Ave.
	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
Canawa (I-22-1125)	37.4	35.8	22.6	28.3	37.3	23.2	37.4	50.0	37.4	52.9	46.5	37.2*
Owner's variety	33.1	32.1	15.9	21.1	34.9	18.3	33.2	35.0	29.2	47.8	34.4	30.5

*Significantly greater than the average of the owner's variety.

MILLING AND BAKING TESTS[5]

Canawa belongs to the soft red winter class of wheat but it has distinctly harder seeds than most wheats in this group. The percentage of hardness or corneousness was estimated by comparing the threshed grain from each plat with samples artificially made up to contain various percentages of corneous seeds. Average percentage of hardness is shown in Table 5.

It is apparent from an examination of columns 2, 3, and 4 that Canawa consistently showed a higher percentage of corneous seed than any of the other varieties. The average estimated percentage of hardness for each variety over the 12-year period follows: Canawa 80.27, Fulhio 62.67, and Trumbull 65.93.

Column 2, Table 6, shows that Canawa weighed somewhat more per bushel than Fulhio or than the average of the 230 samples of soft

[5]The writers are indebted to D. A. Coleman, in charge of milling and baking investigations, Grain Division of the Bureau of Agricultural Economics, U. S. D. A., for the data presented in this section, with the exception of the estimated percent hardness.

winter wheat. In flour yield (column 3) Canawa was slightly superior to Fulhio but distinctly superior to the composite. With respect to percentage of bran and shorts (columns 4 and 5) Canawa yielded the smallest percentage of bran and Fulhio the smallest percentage of shorts. The ash of the flour in column 6 shows little variation. On the other hand the percentage of protein (column 7) shows considerable variation with composite 9.5%, Fulhio 8.4%, and Canawa 7.8%. These data indicate that Canawa has satisfactory milling qualities.

TABLE 5—*Average percent hardness of certain wheats grown from 1923 to 1934 inclusive on the Agronomy Farm at Morgantown*

Year	Average estimated percent hardness of		
	Canawa	Fulhio	Trumbull
(1)	(2)	(3)	(4)
1923	53.0	36.0	45.0
1924	71.2	57.5	59.3
1925	83.7	51.2	79.1
1926	80.0	55.0	62.5
1927	88.7	78.7	85.1
1928	96.5	86.3	83.5
1929	92.5	90.0	88.8
1930	83.8	65.0	71.3
1931	83.8	48.7	62.7
1932	81.3	77.5	76.7
1933	78.8	61.2	48.4
1934	70.0	45.0	28.8
Average	80.27*	62.67	65.93

*Significantly greater than the average for Fulhio or Trumbull.

TABLE 6—*Milling data on Fulhio and Canawa wheat produced at the Agronomy Farm in 1934 and, as a check, the composite milling data from 230 samples of soft winter wheat produced the same year in Ohio, Indiana, and Pennsylvania*

Name	Test weight per bushel (lbs.)	Flour yield %	Bran %	Shorts %	Flour*	
					Ash %	Protein %
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Canawa	62.3	74.5	11.6	11.3	0.41	7.8
Fulhio	60.5	73.5	13.0	9.8	0.38	8.4
Composite	58.5	71.7	13.0	11.3	0.40	9.5

*Basis — 13.5 percent water.

The loaf volume recorded in cubic centimeters in column 2, Table 7, shows that the composite was superior in this respect to either Canawa or Fulhio, and Canawa was superior to Fulhio. With respect to grain and texture (column 3) Canawa was given the highest score. No difference was found in color of crust (column 4), but in color of crumb (column 5) both Canawa and Fulhio were slightly deficient as compared with Composite. The last column shows that the two varieties and Composite produced type M loaf as designated by the

American Association of Cereal Chemists. This type is recognized as possessing average bread characteristics.

In general, the above data show that the baking quality of flour from Canawa is not quite the equal of the average baking qualities found from 230 samples of soft red winter wheats grown in Ohio, Indiana, and Pennsylvania. This result perhaps is to be expected from the low percentage of protein as compared with the composite. These tests indicate that while flour from Canawa probably is more suitable for pastries and biscuits than for bread it, nevertheless, may be expected to give satisfactory results when used for bread, particularly if blended with stronger flours.

TABLE 7—*Baking data on Fulhio and Canawa wheat produced at the Agronomy Farm in 1934 and, as a check, the composite baking data from 230 samples of soft winter wheat produced the same year in Ohio, Indiana, and Pennsylvania*

Name	Loaf volume (c. c.)	Grain and texture score	Color of crust	Color of crumb	A.A.C.C. type loaf
(1)	(2)	(3)	(4)	(5)	(6)
Canawa	473	75	Light brown	65 creamy yel.	M
Fulhio	458	70	Light brown	65 creamy gray	M
Composite	484	70	Light brown	75 creamy yel.	M

SUMMARY

This bulletin contains a brief description of a new variety of wheat named Canawa. It originated from a single head selected from a mixed variety grown on the Agronomy Farm in 1921 under the name of Canada Hybrid.

Canawa is a smooth, soft red winter wheat and has medium-sized spikes that droop when the grain is ripe. The straw is purplish and stiff and has shown very little tendency to lodge. For a wheat belonging to the soft red winter class, Canawa has seeds that are relatively hard.

The yielding ability of Canawa as revealed by the experimental tests, is equal to that of Fulhio, a high yielding wheat under West Virginia conditions. In cooperative tests with farmers, Canawa produced significantly greater average yields than did the wheats now commonly grown.